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## 273. Proposed by A. H. HOLMES, Brunswick, Maine.

Required a purely geometrical solution of the problem, to find the contents of a solid generated by the revolution of a semi-segment of a circle about the sine of its arc.

## Solution by the PROPOSER.

*HBO* is a quadrant whose revolution about *BO* as an axis generates a hemisphere. *BAF* is a semi-segment of radius=*BO*. Draw *AM* parallel to *HB* and *MI* parallel to *BO*. Suppose the quadrant to revolve about its axis a very small distance, the point *H* moving to *L* so as to generate *HBOLB*, *M* falling on *N*. Through *NE* pass a plane parallel to *HBO*. The semi-segment *HMI*=*AFB* generates *HIELMN*; of which the part *EKLN*=part generated by *BAF*.

It is obvious that the volume generated by the semi-segment *BFA* in an entire revolution will equal that generated by *HMI* minus the sum of the solids *HIKEMN* lying about the circumference of the base of the hemisphere.

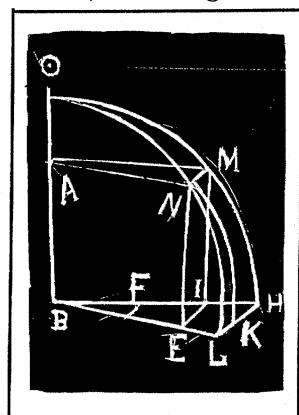
But  $MNHIEK = IE \times \text{area of the semi-segment}$  and the entire sum of all these is equal to the circumference described by *BI* as radius into the same area. If we put  $BO=r$ ,  $BE=c$ ,  $BA=s$ , and arc  $AF=a$ , we obtain for the solid generated by

$BOMI$ ,  $\frac{2\pi}{3}(sc^2 + r^3 - r^2s)$ . Consequently, for the solid generated by *HIM*,

$\frac{2\pi}{3}(r^2s - sc^2)$ . The sum of all the solids *HKEINM*=semi-segment  $MHI \times 2\pi c = \pi(c a r - s c^2)$ . Consequently the volume sought is

$$= \frac{2\pi}{3}(r^2s - sc^2) - \pi(c a r - s c^2) = \pi\left(\frac{sc^2}{3} + \frac{2r^2s}{3} - c a r\right).$$

Putting  $c^2 = r^2 - s^2$ , this becomes  $\pi(s r^2 - s^3/3 - c a r)$ .



## GROUP THEORY.

## 14. Proposed by O. E. GLENN, Springfield, Mo.

Hölder has proved\* that any group (*G*) of order  $\sum_{i=1}^n p_i$  ( $p_i$  a prime  $\neq p_j$ ) may be generated as follows:  $M^\mu = N^\nu = 1$ ,  $N^{-1}MN = M^\alpha$ , where  $\{M\}$  is the product of all the invariant subgroups of *G* of prime order and  $\{N\}$  is any one of a set of conjugate cyclical subgroups of order  $\nu$ , ( $\sum_{i=1}^n p_i = \mu\nu$ ). Find the generating relations of *G* in terms of operations of prime order, and express *M* and *N* in terms of these operations, for  $n=4$ .

\*See Burnside, *Theory of Groups*, p. 353.